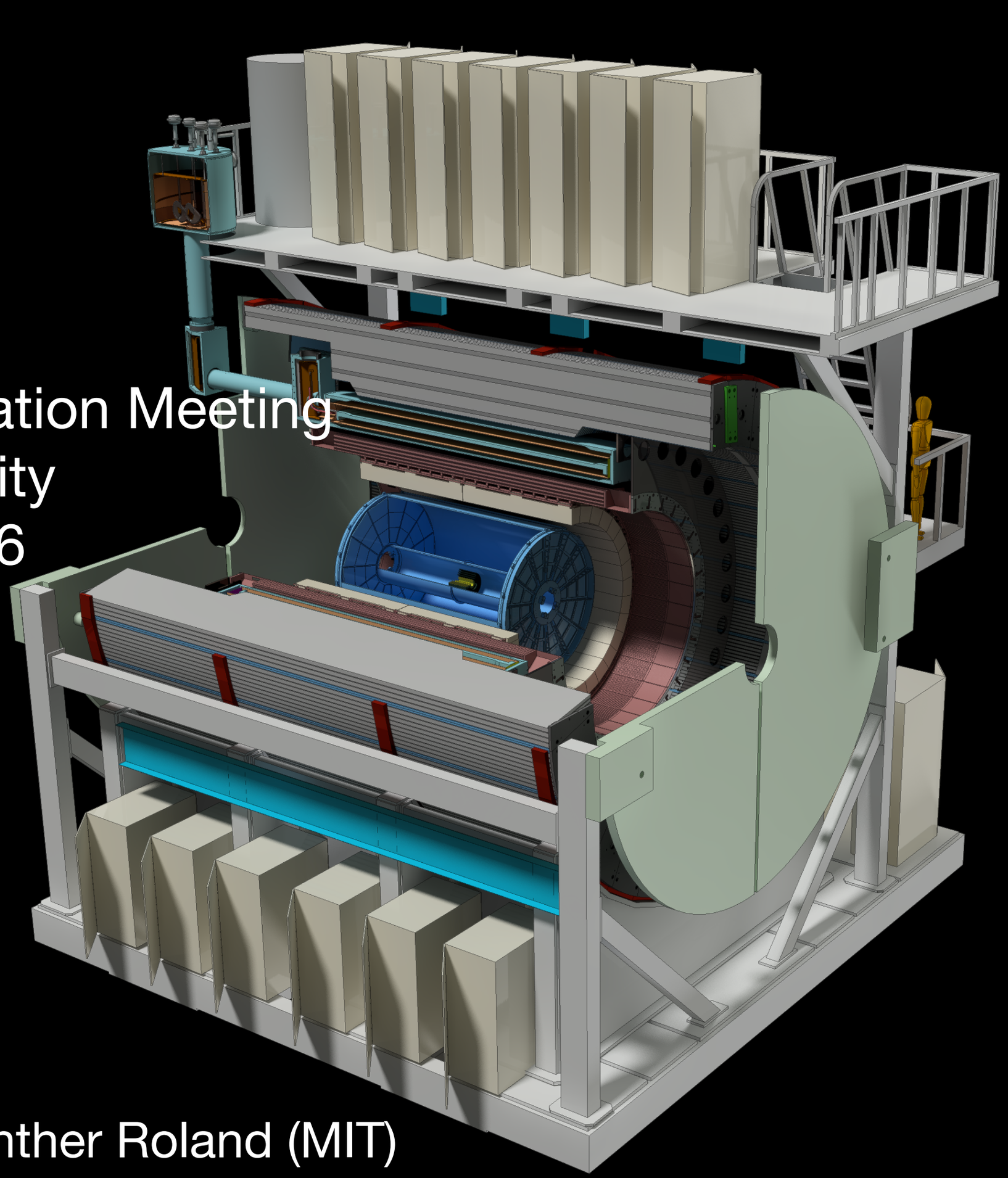
# 3rd sPHENIX Collaboration Meeting

Georgia State University

December 15-17, 2016



Dave Morrison (BNL), Gunther Roland (MIT)

Thank you, GSU!  Thanks especially to Megan Connors, Xiaochun He and all the GSU locals!


Georgia State University

About scheduling a meeting in December, “Nobody goes there anymore. It's too crowded.” – Yogi Berra

# Six-year history of development

sPHENIX Concept in the PHENIX Decadal Plan (charged by ALD Steve Vigdor):
October 2010. PHENIX spokesperson Barbara Jacak asked Jamie Nagle to coordinate development of document.

Original proposal http://arxiv.org/abs/1207.6378: July 2012
(new superconducting solenoid & optional additional tracking)

BNL Review (chaired by Tom Ludlam) of sPHENIX proposal: October 2012

Updated sPHENIX proposal: October 2013

BNL Review (chaired by Sam Aronson) of “ePHENIX” LOI: January 2014

“ePHENIX” White Paper (http://arxiv.org/abs/1402.1209): February 2014

Future Opportunities in p+p and p+A with the Forward sPHENIX Detector: April 2014

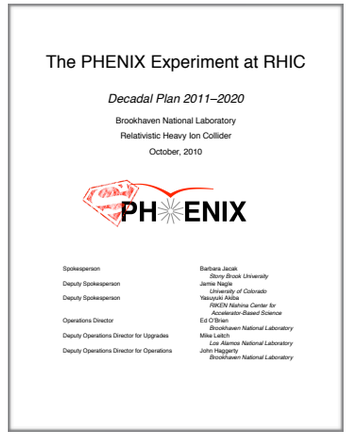
Updated proposal, submitted to DOE: June 2014 (incorporation of Babar magnet and tracking)

DOE Science Review: July 2014

Updated Proposal http://arxiv.org/abs/1501.06197 : November 2014

DOE Science Review (chaired by Tim Hallman): April 2015

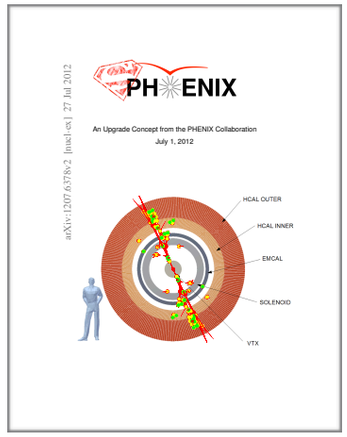
sPHENIX pCDR: November 2015

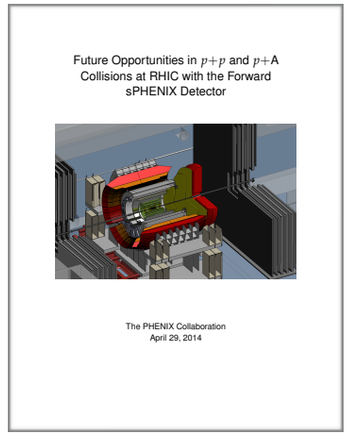

The PHENIX Experiment at RHIC

*Decadal Plan 2011–2020*

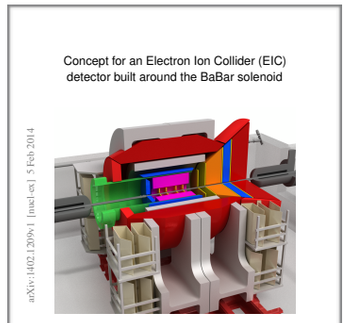
Brookhaven National Laboratory
Relativistic Heavy Ion Collider
October, 2010

PHENIX





Future Opportunities in $p+p$ and $p+$A Collisions at RHIC with the Forward sPHENIX Detector

The PHENIX Collaboration
April 29, 2014

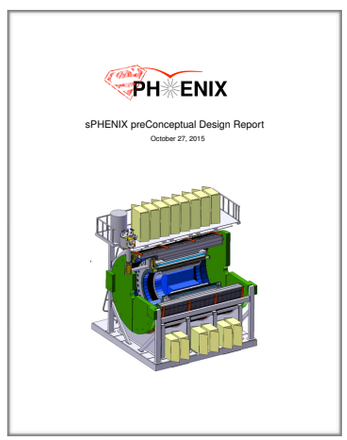




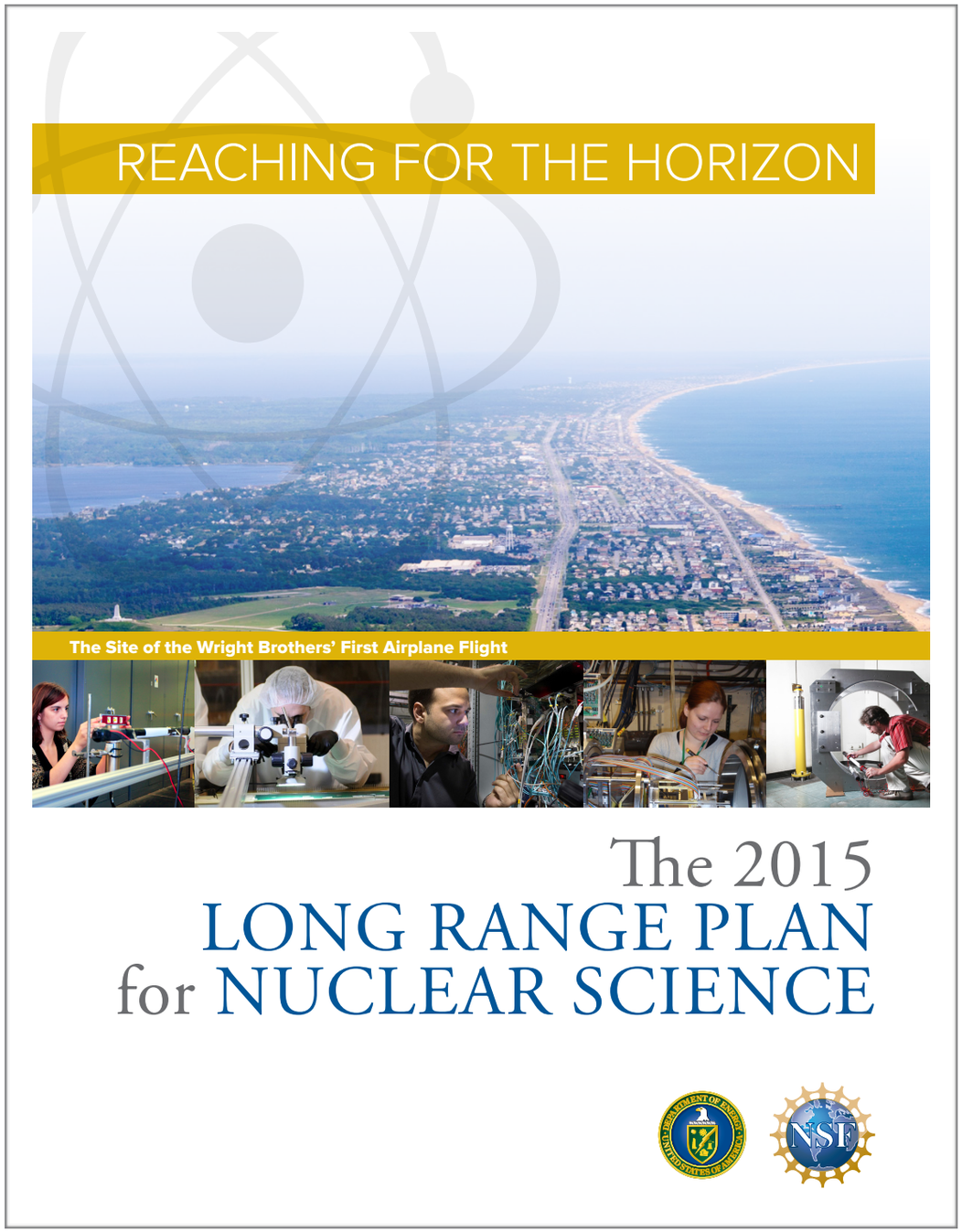
PHENIX

*An Upgrade Proposal from the PHENIX Collaboration*

Original: July 1, 2012
Updated: October 1, 2013
Updated: June 19, 2014
Updated: November 19, 2014



Celebrating at the BNL Center after submitting the sPHENIX proposal




**RECOMMENDATION I**

**The progress achieved under the guidance of the 2007 Long Range Plan has reinforced U.S. world leadership in nuclear science. The highest priority in this 2015 Plan is to capitalize on the investments made.**

- *With the imminent completion of the CEBAF 12-GeV Upgrade, its forefront program of using electrons to unfold the quark and gluon structure of hadrons and nuclei and to probe the Standard Model must be realized.*
- *Expeditiously completing the Facility for Rare Isotope Beams (FRIB) construction is essential. Initiating its scientific program will revolutionize our understanding of nuclei and their role in the cosmos.*
- *The targeted program of fundamental symmetries and neutrino research that opens new doors to physics beyond the Standard Model must be sustained.*
- *The upgraded RHIC facility provides unique capabilities that must be utilized to explore the properties and phases of quark and gluon matter in the high temperatures of the early universe and to explore the spin structure of the proton.*

**RECOMMENDATION III**

*Gluons, the carriers of the strong force, bind the quarks together inside nucleons and nuclei and generate nearly all of the visible mass in the universe. Despite their importance, fundamental questions remain about the role of gluons in nucleons and nuclei. These questions can only be answered with a powerful new electron ion collider (EIC), providing unprecedented precision and versatility. The realization of this instrument is enabled by recent advances in accelerator technology.*

**We recommend a high-energy high-luminosity polarized EIC as the highest priority for new facility construction following the completion of FRIB.**

**RECOMMENDATION IV**

**We recommend increasing investment in small-scale and mid-scale projects and initiatives that enable forefront research at universities and laboratories.**

There are two central goals of measurements planned at RHIC, as it completes its scientific mission, and at the LHC: **(1) Probe the inner workings of QGP by resolving its properties at shorter and shorter length scales. The complementarity of the two facilities is essential to this goal, as is a state-of-the-art jet detector at RHIC, called sPHENIX. (2) Map the phase diagram of QCD with experiments planned at RHIC.**

# Inaugural sPHENIX collaboration meeting

Rosi Reed (Lehigh)

Sevil Salur (Rutgers)

Hosts

# 2016 Highlights

- Established collaboration structure
- ALD baseline-scope charge and collaboration response
- Virtuality evolution of sPHENIX tracker
- Received CD-0; on to CD-1
- Growing the collaboration

# Collaboration structure

# Collaboration structure

**Executive Council**
Megan Connors (junior)
Sarah Campbell (junior)
Tom Hemmick
John Lajoie
Anne Sickles
Bill Zajc
Joern Putschke
Jamie Nagle
Huan Huang
Itaru Nakagawa
Christine Aidala
Ed OBrien (ex officio)
Gunther Roland (ex officio)
Dave Morrison (ex officio)

**Executive Council**
Project and collaboration representatives

## Topical Groups

- **Jet structure**
  D. Perepelitsa, R. Reed
- **Heavy flavor**
  J. Huang, M. McCumber
- **Y spectroscopy**
  T. Frawley, M. Rosati
- **Cold QCD**
  C. Aidala, N. Feege

**Institutional Board**
Institution representatives

**sPHENIX Collaboration**
Co-Spokespersons
**D. Morrison**
**G. Roland**

**Support Office**
**P. Giannotti** ES&H
**J. Eng** QA

Office of Nuclear Physics
**J. Gillo**
Director of Facilities & Project Management Div
**E. Bartosz**
Program Manager

BHSO
**F. Crescenzo**
Site Manager
**L. Nelson**
Federal program Director

BNL Nuclear and Particle Physics Directorate
**B. Mueller**
Associate Lab Director
**D. Lissauer**
**T. Roser**
Deputy Associate Lab Directors

Project Management Group

**Project Office**
**E. O'Brien** Project Director
**J. Haggerty** Project Manager – Science
**J. Mills** Project Manager - Engineering
**D. Lynch** Chief Engineer
**I Sourikova** Project Controls
**R. Ernst** Resource Coordinator

BNL Physics Dept
**L. Littenberg**
**J. Dunlop**

Project Management Office
WBS 1.1
**I. Sourikova**
**R. Ernst**

Engineering and Facilities
**J. Mills**
- WBS 1.2 Magnet — **K. Yip**
- WBS 1.8 Infrastructure — **P. Giannotti**
- WBS 1.9 Install & Integration — **D. Lynch**

Science
**J. Haggerty**
- WBS 1.3 Tracker — **I Nakagawa** Silicon, **T. Hemmick** TPC
- WBS 1.4 EMCal — **C. Woody**
- WBS 1.5 HCal — **J. Lajoie**
- WBS 1.6 Cal Electronics — **E. Mannel**
- WBS 1.7 DAQ/Trigger — **CY Chi**

# Close connection of collaboration and project: Fortnightly General Meetings

Fortnightly meetings to discuss project and collaboration news:

- Reports from collaboration and project management
- Reports from detector and physics/ simulations efforts

Open to all collaborators; good attendance

10th sPHENIX Fortnightly General Meeting

Friday, August 5, 2016 from **12:00** to **14:00** (US/Eastern)
at **Universe ( 2-219 )**

**Description** To join the Meeting:
https://bluejeans.com/913283451

To join via Browser:
https://bluejeans.com/913283451/browser

To join with Lync:
https://bluejeans.com/913283451/lync

To join via Cisco Jabber Video:
https://bluejeans.com/913283451/jabber

To join via Room System:
Video Conferencing System: bjn.vc -or- 199.48.152.152
Meeting ID : 913283451

To join via phone :
1) Dial:
+1.408.740.7256
+1.888.240.2560
+1.408.317.9253
(see all numbers - http://bluejeans.com/numbers?tl=en)
2) Enter Conference ID : 913283451

**Friday, August 5, 2016**

12:00 - 12:20 sPHENIX News *20'*
Speakers: Dr. David Morrison (BNL), Prof. Gunther Roland (MIT)
Material: Slides

12:20 - 12:40 sPHENIX Project News *20'*
Speaker: Edward O'Brien (BNL)
Material: Slides

12:40 - 13:00 Tracking status and plans for tracker review *20'*
Speakers: Dr. Anthony Frawley (Florida State University), Dr. Michael McCumber (Los Alamos National Laboratory)
Material: Slides

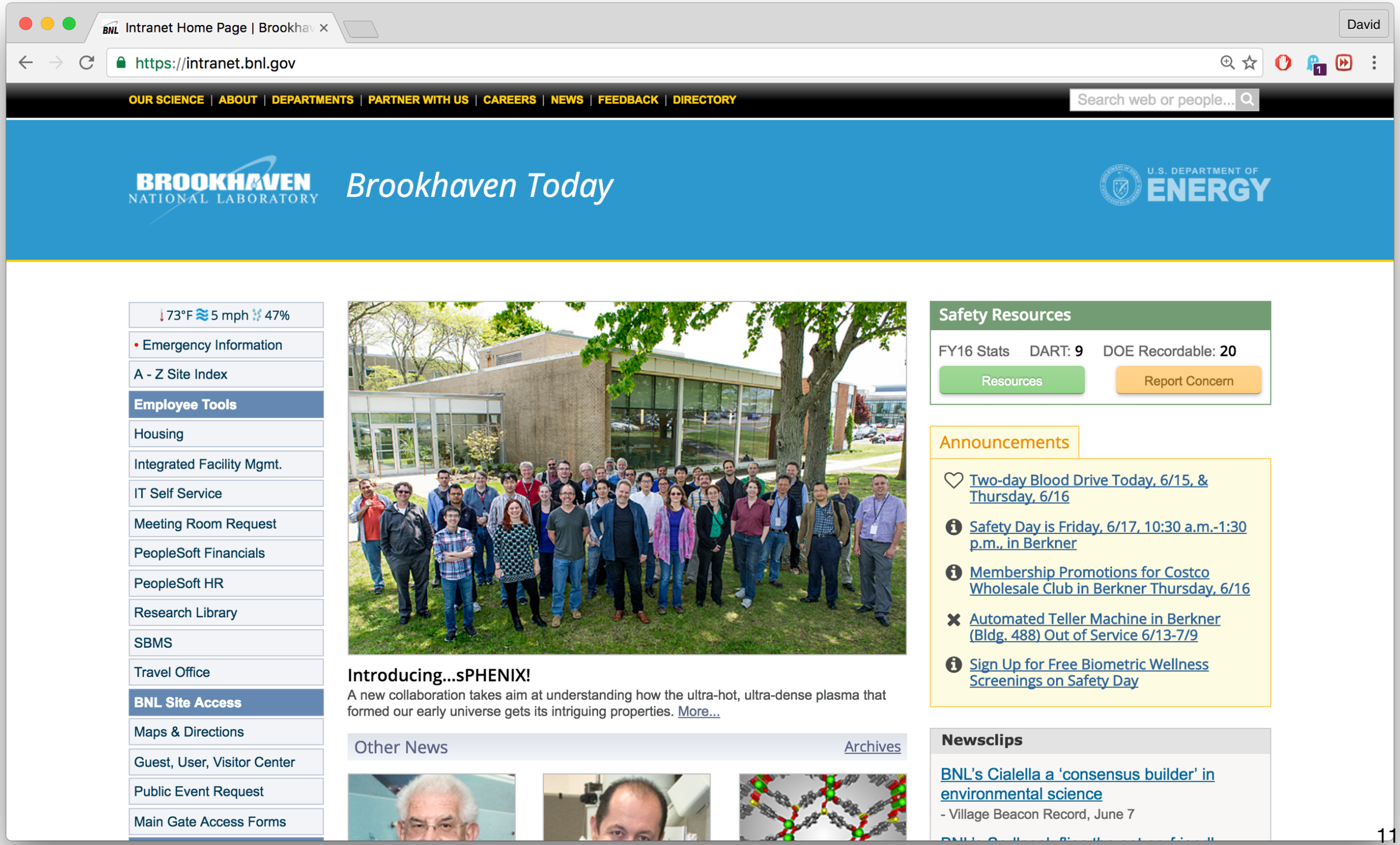
13:00 - 13:15 Jet structure topical group plans for tracker review *15'*
Speakers: Dr. Dennis Perepelitsa (Brookhaven National Laboratory), Dr. Rosi Reed (Lehigh University)
Material: Slides

13:15 - 13:30 HF topical group plans for tracker review *15'*
Speakers: Dr. Jin Huang (Brookhaven National Lab), Dr. Michael McCumber (Los Alamos National Laboratory)
Material: Slides

13:30 - 13:45 Upsilon topical group plans for tracker review *15'*
Speakers: Prof. Marzia Rosati (Iowa State University), Dr. Anthony Frawley (Florida State University)

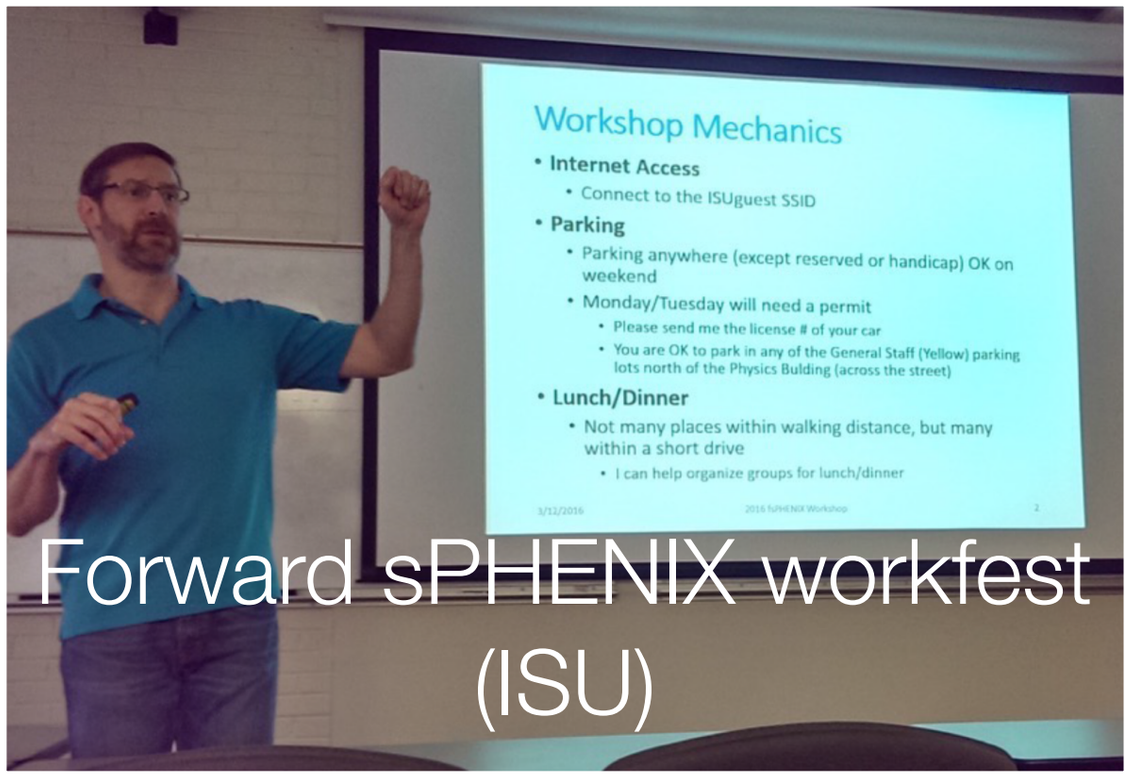
13:45 - 14:00 TPC electronics mini-workfest report *15'*
Speaker: Prof. Thomas Hemmick (Stony Brook University)
Material: Slides

# Second sPHENIX collaboration meeting May 2016



# Focused “workfests” and other events






- Continues practice that was very productive in developing sPHENIX proposals
- Invite outside experts when appropriate – e.g., discussion with ALICE & STAR experts on space charge distortion in TPC

# ALD baseline charge and collaboration response

# ALD baseline charge and collaboration response

"I have therefore requested that sPHENIX Project Management, in close collaboration with the sPHENIX Collaboration, develops a credible plan encompassing an option of baseline design scope, cost, and schedule that will allow the detector to be completed on schedule for data taking in the FY2022 RHIC run within the presently foreseen DOE funding profile, and that the sPHENIX Project Management present this plan to BNL management no later than May 31, 2016. The plan should maintain the 40% contingency requested by the cost and schedule review. This plan should not assume the availability of additional funding from non-DOE sources, but may describe which elements would be added to the baseline scope of sPHENIX if additional funding became available."

# Collaboration response

- 30 page document (June 6)
- Joint product of collaboration and project

**Table 1:** Cost reduction scenarios identified by the scientific collaboration in consultation with the project that signficantly reduce the M&S costs while preserving a compelling science program. Both scenarios involve very serious cuts to detectors and represent very unfortunate degradations in capability. Both scenarios have significantly worsened $e/\pi$ separation, acceptance for Ys and photons, and suffer a longer time before reconstructed data would be available. Both scenarios identify a path to restore capabilities should additional funding become available. The scenario on the left retains the ability to identify displaced tracks, preserving HF-tagged jet capability. The scenario on the right sacrifices even this key physics capability. Cost differences are in $M, relative to the sPHENIX pTDR configuration.

| Scenario A | Δ | Scenario B | Δ |
|---|---|---|---|
| two-layer MAPS inner barrel | +3.0 | one-layer MAPS inner barrel | +2.1 |
| no reuse of VTX | −0.2 | no reuse of VTX | −0.2 |
| reduce TPC readout | −0.5 | reduce TPC readout | −0.5 |
| reduce EMCal segmentation | −1.8 | reduce EMCal segmentation | −1.8 |
| reduce EMCal $\eta$ acceptance | −2.0 | further reduce EMCal $\eta$ acceptance | −2.2 |
| reduce DAQ refresh | −0.5 | reduce DAQ refresh | −0.5 |
| reuse beam-beam trigger counter | −0.5 | reuse beam-beam trigger counter | −0.5 |
| Total | −2.5 | Total | −3.6 |

- Agreed on tough choices (reduced EMCAL, added MAPS)
- Never received formal response from ALD
- BUT: established credibility; basis for current project scope

# Project scope (Sep-Oct)

| WBS | sPHENIX MIE Project Elements |
|---|---|
| **1.1** | Project Management |
| **1.2** | Time Projection Chamber & MAPS Telescope |
| **1.3** | Electromagnetic Calorimeter |
| **1.4** | Hadron Calorimeter |
| **1.5** | Calorimeter Electronics |
| **1.6** | DAQ-Trigger |
| **1.7** | Minimum Bias Trigger Detector |

Table 1: sPHENIX MIE WBS Structure

| WBS | Infrastructure & Facility Upgrade WBS |
|---|---|
| **1.8** | SC-Magnet |
| **1.9** | Infrastructure |
| **1.10** | Installation-Integration |

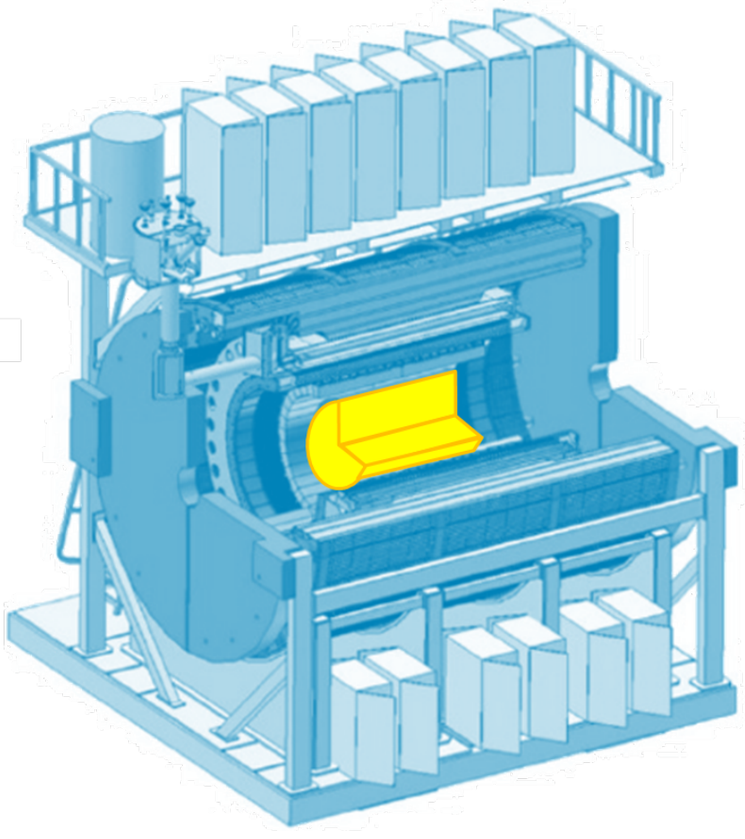
Table 2: 1008 Facility Upgrade WBS Structure

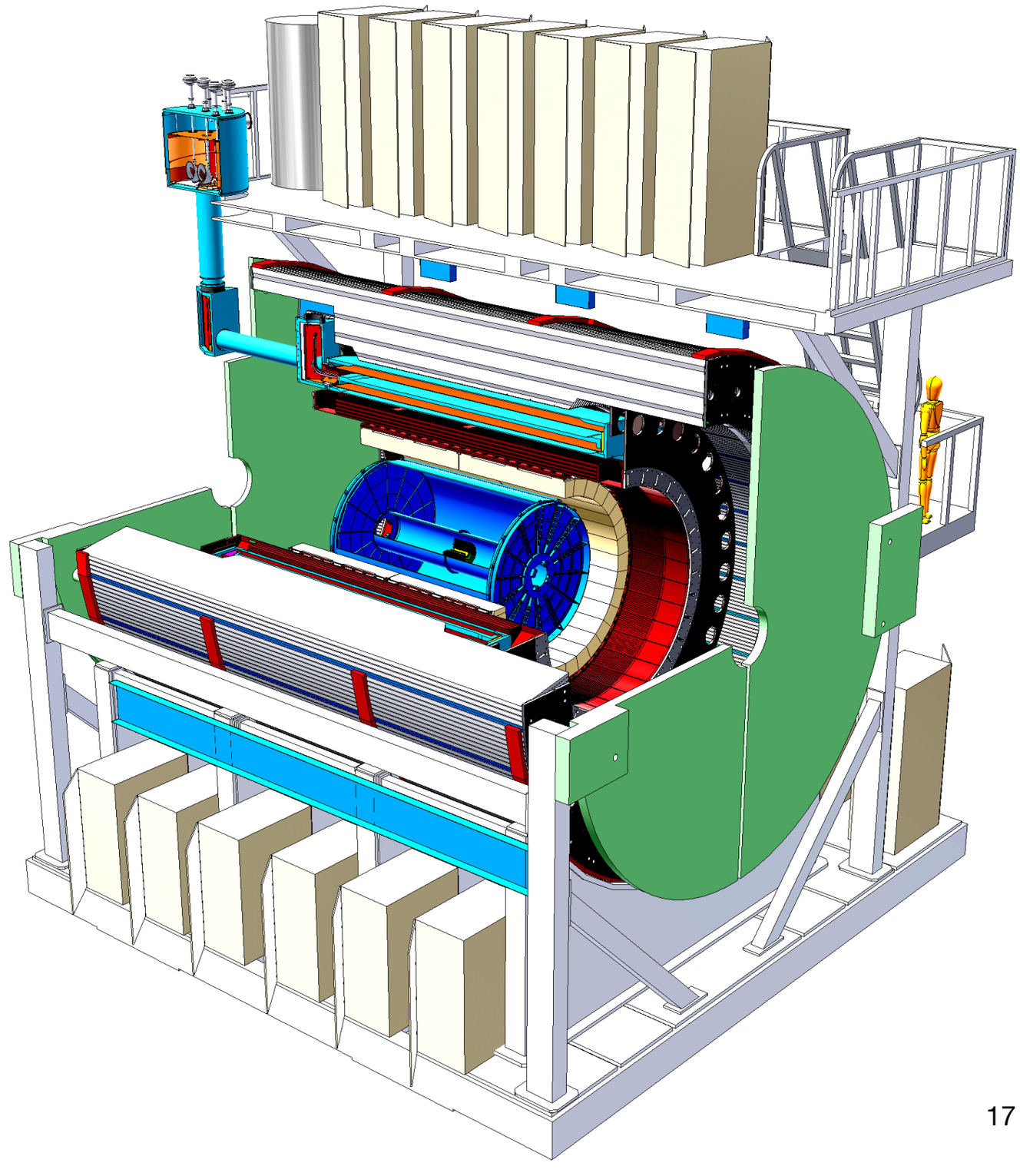
| WBS | Parallel Activities |
|---|---|
| **1.11** | Intermediate Silicon Strip Tracker |
| **1.12** | Monolithic Active Pixel Sensors |

Table 3: Parallel Activities in support of sPHENIX

funding outside of DOE baseline

# Evolution of tracker concept





# Evolution of the tracker concept

- Santa Fe MAPS workfest: Copy ALICE IB
- TPC studies promise control over distortions
- Response to ALD: Commitment to MAPS and TPC
- LANL MAPS LDRD approved
- INTT proposal
- Successful tracker review at BNL
- Established MAPS consortium
- Working on MAPS proposal: Workfest in early January

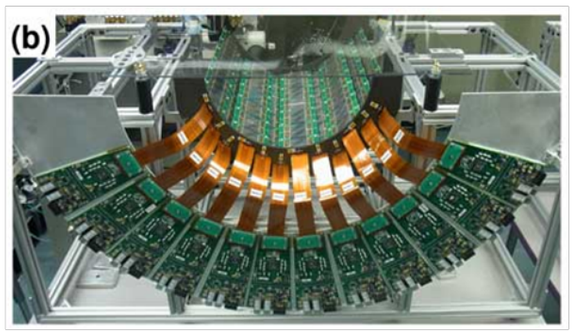
Rutgers 2015

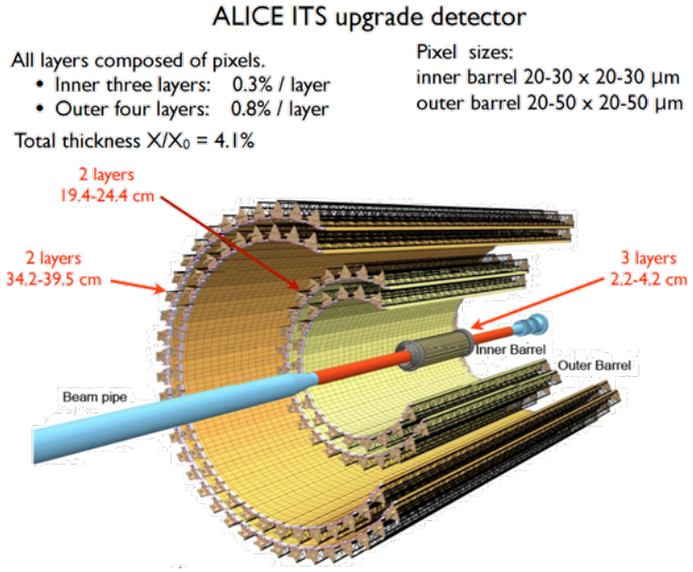
# Matrix of tracker technologies

## Inner tracker

### Reuse PHENIX VTX Components

- Momentum Resolution Limited by Multiple Scattering.
- Significant Dead Area (non-working & gaps)



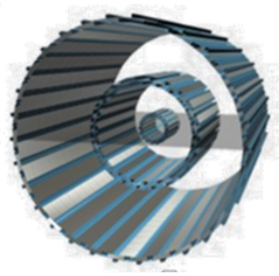




Existing PHENIX pixel detector currently achieves 60 μm @ $p_T > 2$ GeV/c DCA resolution (50 μm evt vertex; 30 μm pixel) – MAPS technology would improve this due to smaller pixels and less material.

## Outer tracker

### New PHENIX-like Components

- Straightforward technology.
- Fast (no event pileup).
- Multiple-Scat limited.
- Little PID capability



### Compact TPC (ala ALICE?)

- Higher momentum resolution
- Smaller Bremsstrahlung tails.
- Leverage ALICE R&D
- PID via dE/dx & neutral V's.

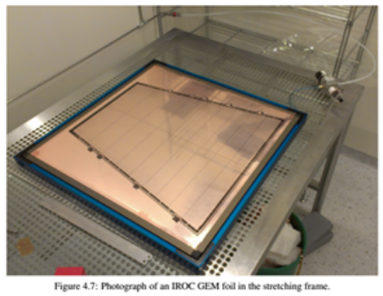
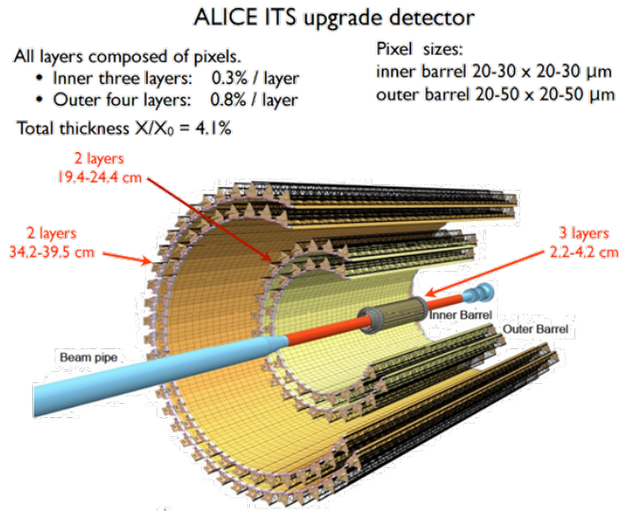
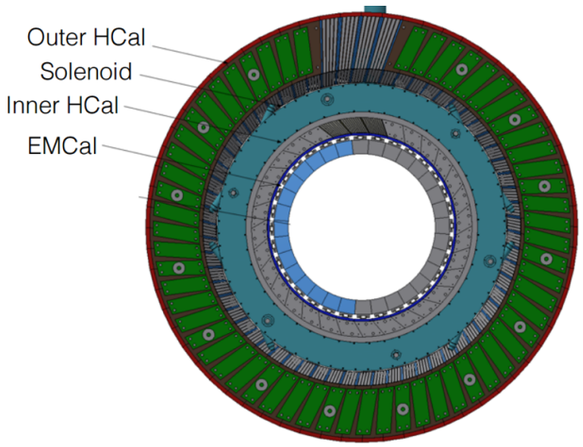



Figure 4.7: Photograph of an IROC GEM foil in the stretching frame.



# Tracker concept

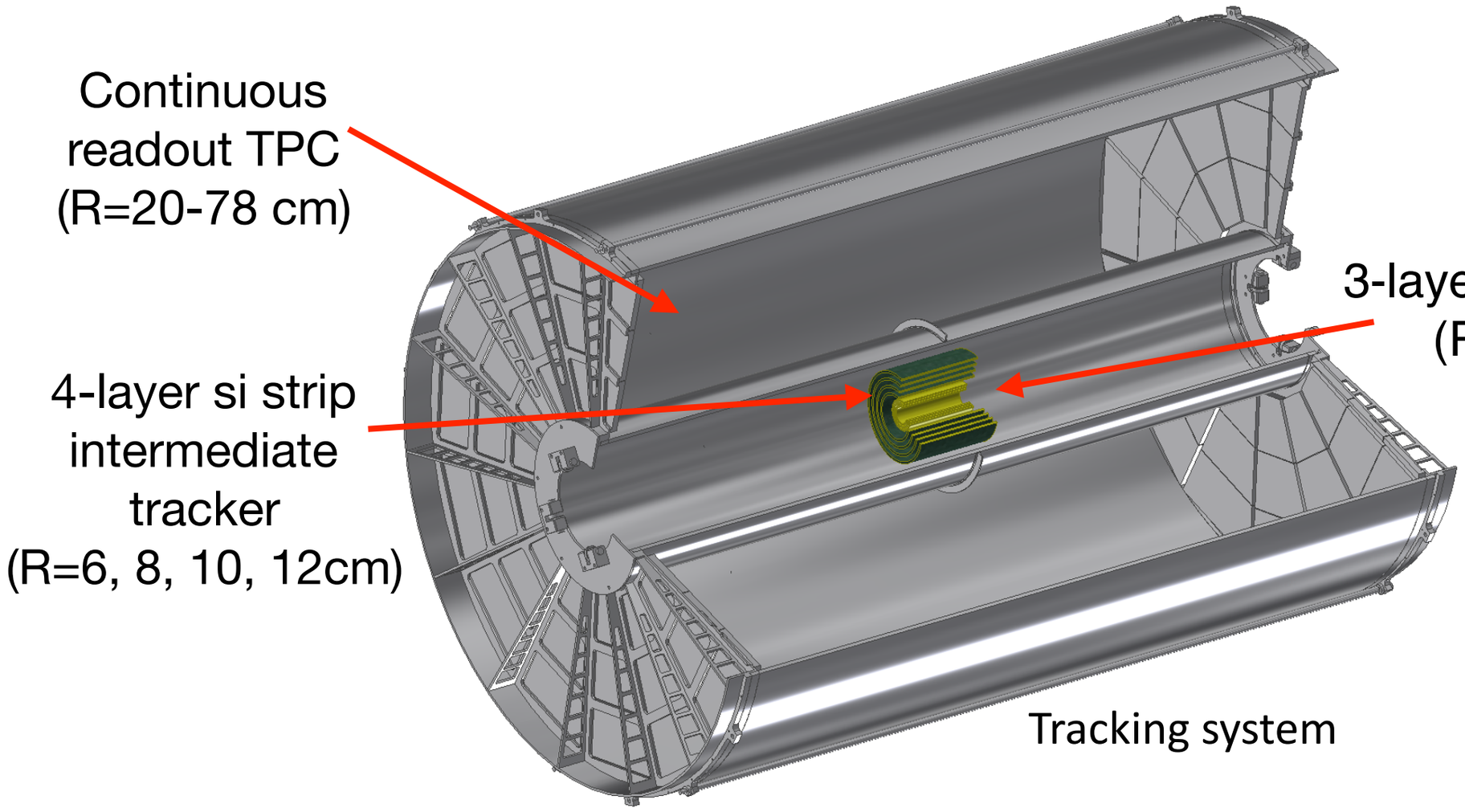
Calorimeter system




Track reconstruction over 2π, |η| ~ 1, 0.2GeV < $p_T$ < 40GeV

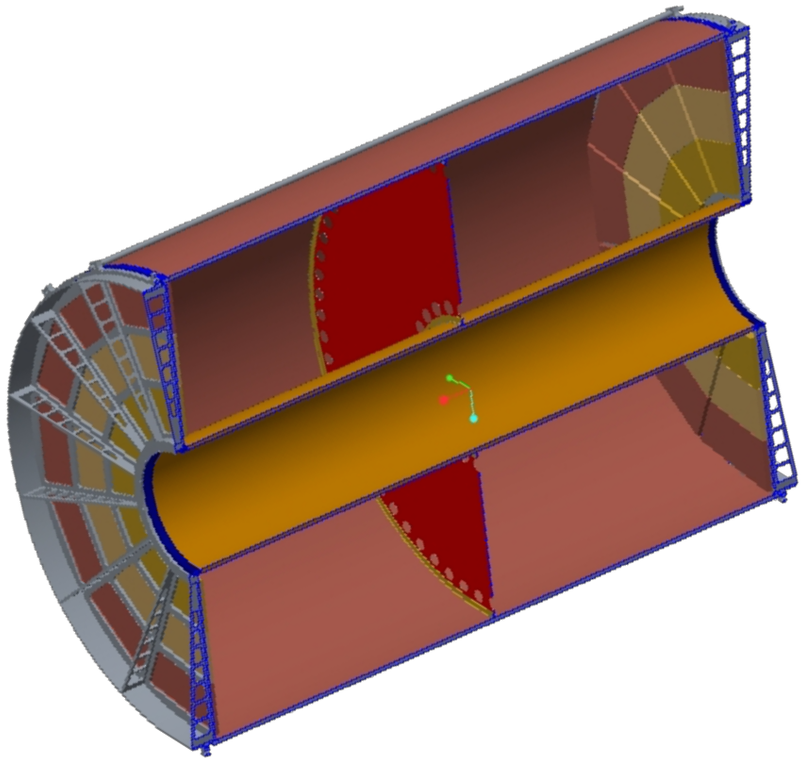
Outer radius constrained by EMCal geometry: $R_{outer}$<78cm
Inner radius constrained by beam pipe: $R_{inner}$>2.1cm

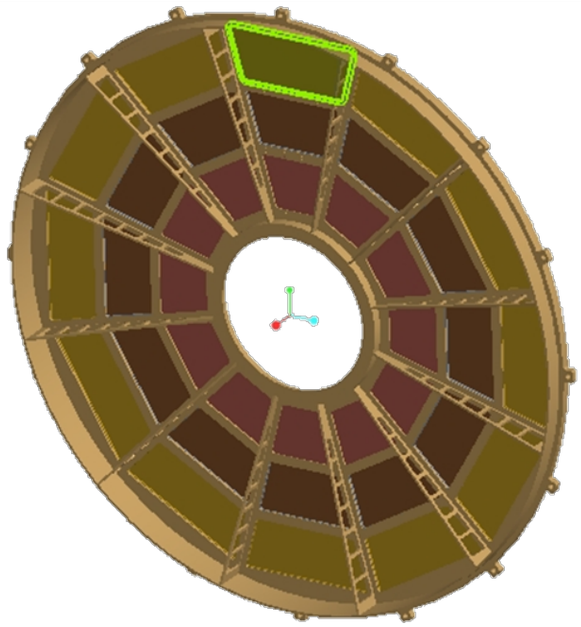
Three detector subsystems to provide primary+secondary vertex, pattern recognition, momentum resolution:

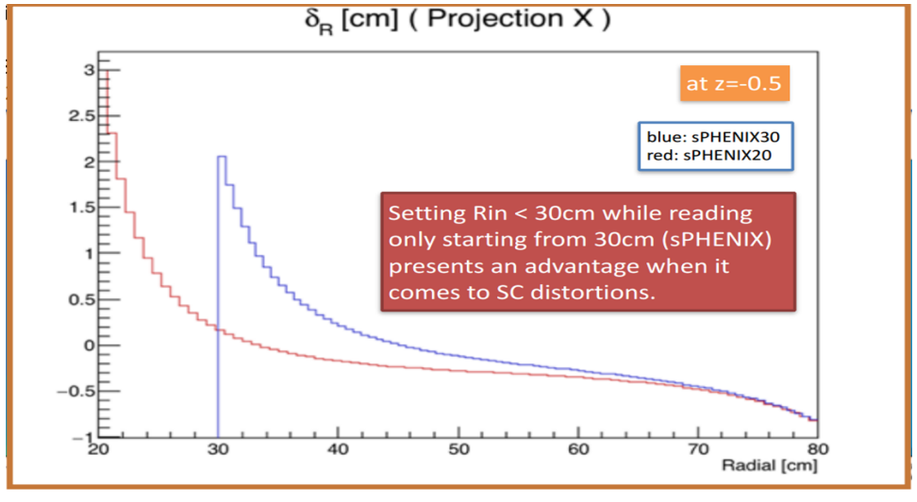



Tracking system

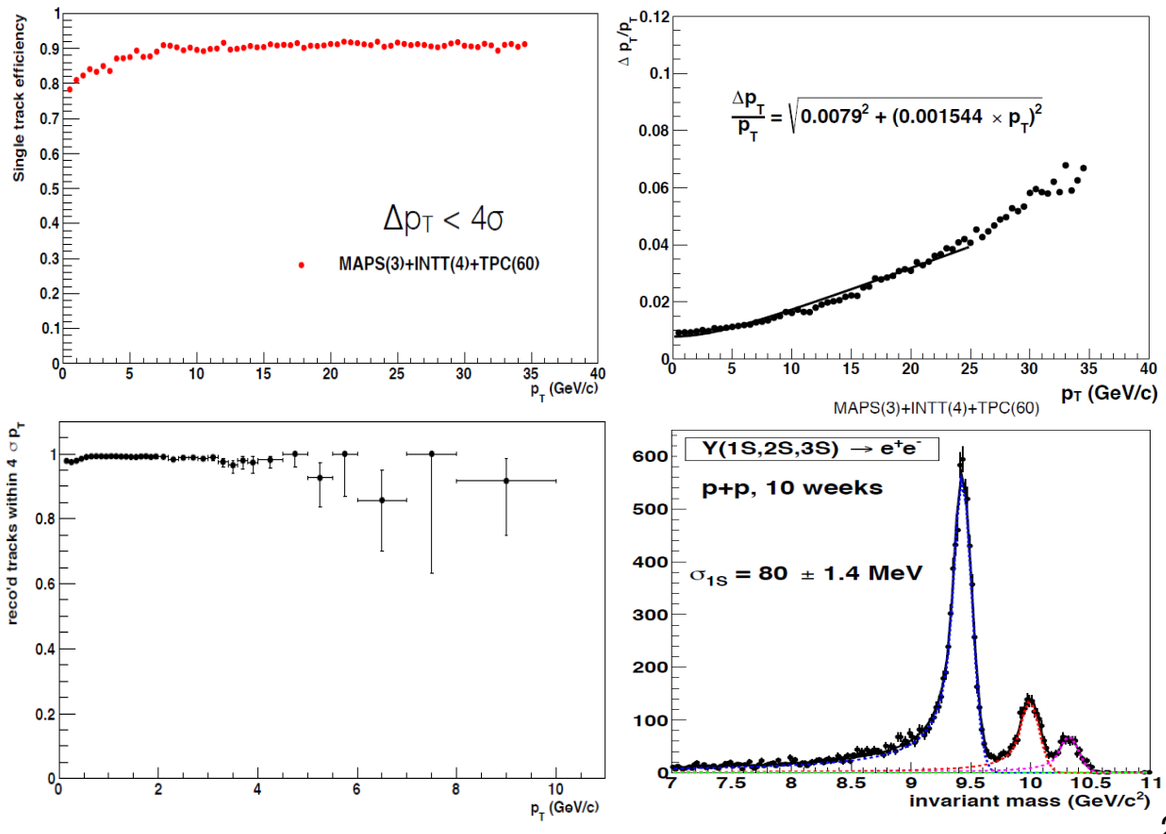
# Rapid progress understanding TPC







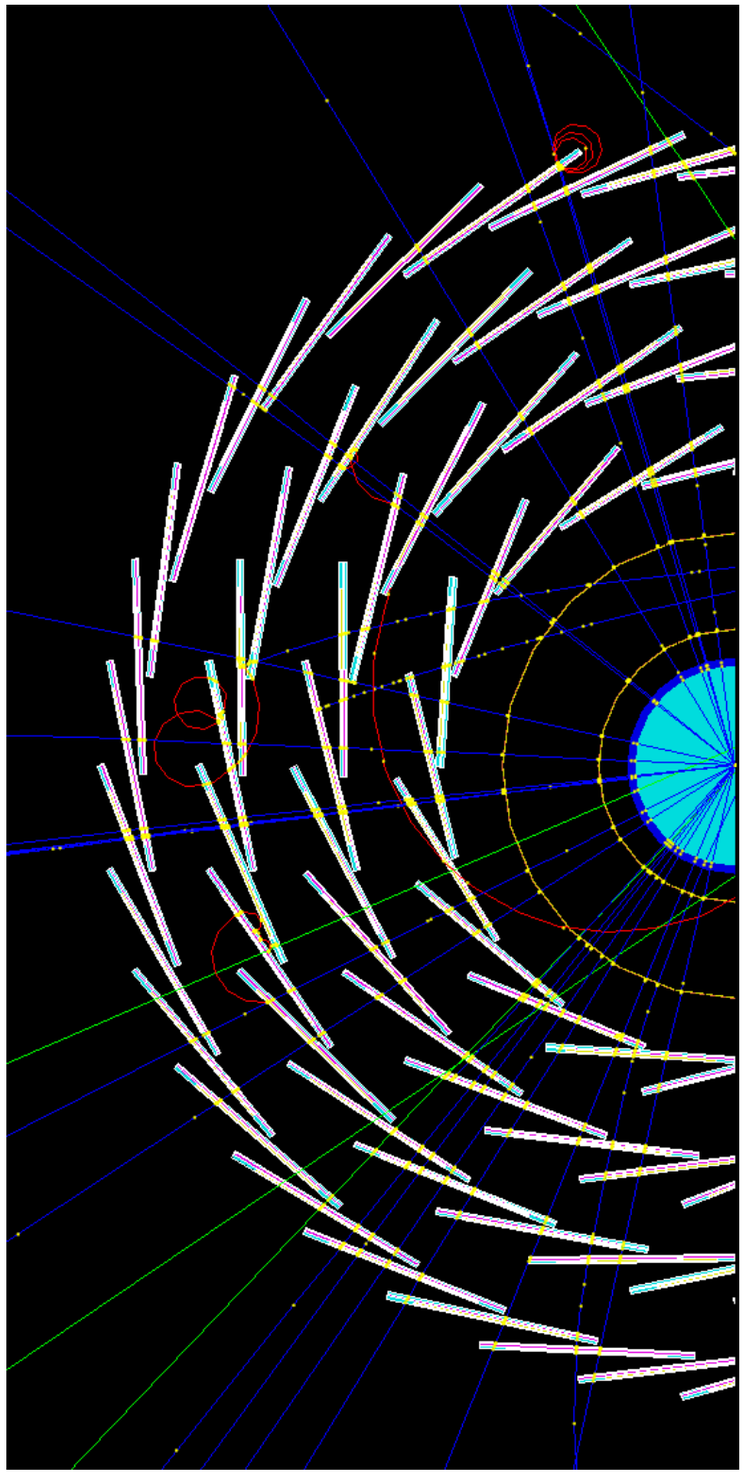

Note: Because of the 1.5 T field, the rdϕ distortion in sPHENIX is comparable to dr.

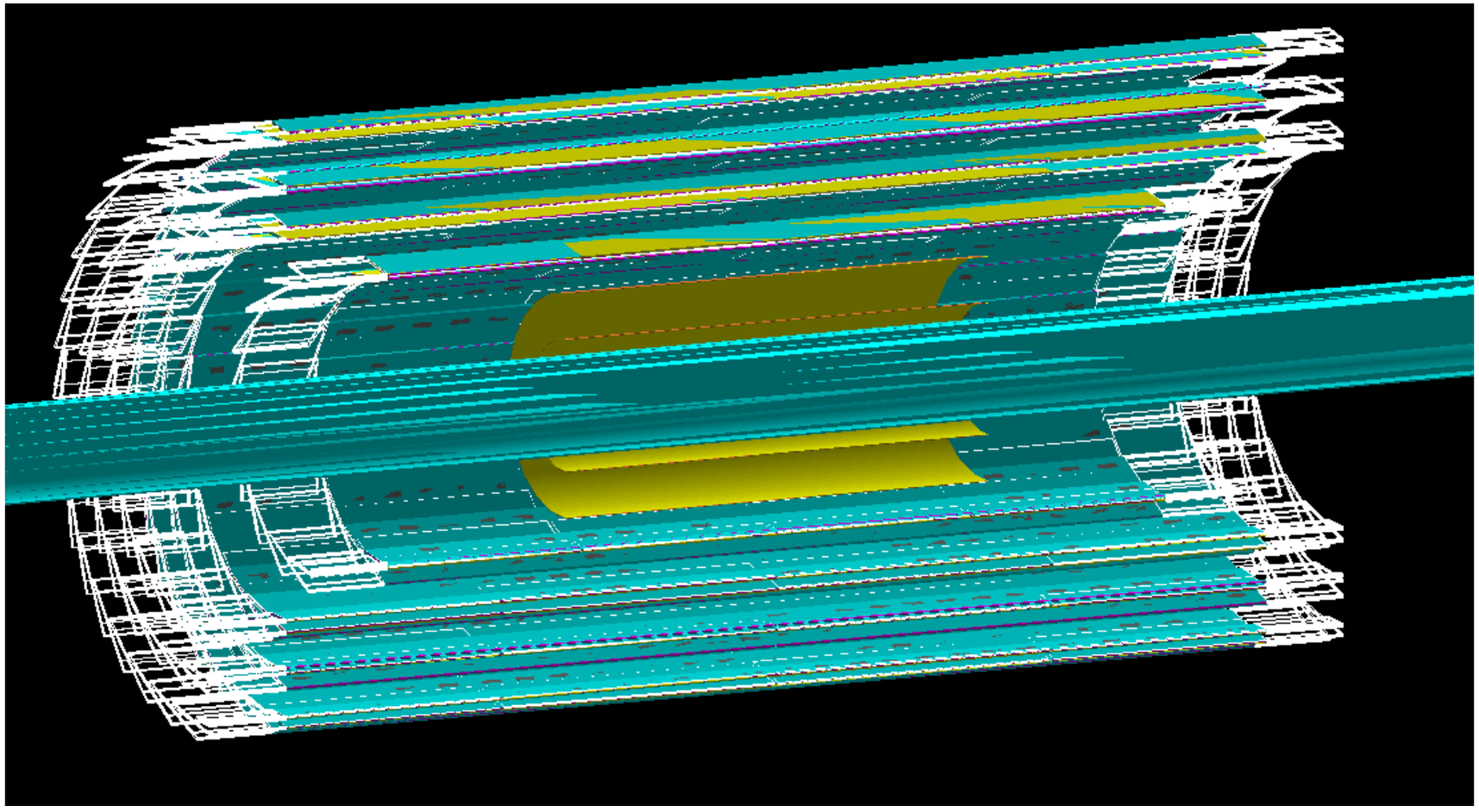



T. Hemmick

Simulation Studies of full tracking system

# Realistic INTT geometry in GEANT4





G. Mitzuka

INTT provides additional space points and single event response

# Associate Laboratory Director's Design Review of the sPHENIX Tracker

from Wednesday, 7 September 2016 at **08:00** to Thursday, 8 September 2016 at **18:00** (US/Eastern)
at **BNL Instrumentation ( A-122 )**

Manage

**Description**

1) +1.408.740.7256 (US)
+1.888.240.2560 (US Toll Free)
+1.408.317.9253 (Alternate number)
Meeting ID:961358759
Meeting URL:https://bluejeans.com/961358759

**Material**

- Charge
- Committee Membership
- Cost and Schedule Review report 2015
- DOE Science Review Report
- INTT BOE
- MAPS BOE
- MAPS Project File
- MAPS WBS Dictionary
- Quality Assurance Plan
- SAMPA Report June2016
- Safety and Hazard Analysis
- TPC Basis of Estimate
- TPC MS_Project file
- TPC Project file in pdf
- TPC Risk Registry
- TPC WBS Disctionary
- agenda
- pCDR
- sPHENIX Upgrade Proposal

## Wednesday, 7 September 2016

08:35 - 09:05 **sPHENIX Project Overview** *30'*

Speaker: Dr. Edward O'Brien (BNL)

Material: Slides

09:05 - 09:30 **Tracker Overview/Physics Performance Parameters** *25'*

Speakers: Prof. Gunther Roland (MIT), Dr. David Morrison (BNL)

Material: Slides

# MAPS MIE proposal and HF-jet Topical Group Workfest

5-7 January 2017 *Santa Fe, NM*
US/Mountain timezone

Search



MAPS detector group and HF-jet topical group invites you to this sPHENIX workfest @ Santa Fe, NM. The goals of this workfest are

- MAPS detector group
  - Make significant progress on MAPS MIE proposal
  - Update the cost and schedule to be ready for discussion with DOE in Feb budget meeting
  - Develop additional physics cases for MAPS detector beyond sPHENIX scientific proposal
- HF-jet topical group
  - Produce near final *b*-jet tagging performance plot for MAPS proposal and QM2017 conference
  - Advance the tracking detector simulation towards new baseline simulation configuration
  - Develop B-meson simulations

# CD-0

| Project Phase | Critical Decision |
|---|---|
| **Initiation**<br>There is a need that cannot be met through other than material means. | CD-0, Approve Mission Need |
| **Definition**<br>The selected alternative and approach is the optimum solution. | CD-1, Approve Alternative Selection and Cost Range |
| **Execution**<br>Definitive cost, scope, and | CD-2, Approve Performance Baseline |
| schedule baselines have been developed. | |
| **Execution Project**<br>is ready for implementation. | CD-3, Approve Start of Construction |
| **Transition/Closeout**<br>Project is ready for turnover or transition to operations. | CD-4, Approve Start of Operations |

# CD-0

six years of development by many, many people …

Subject: sPHENIX
Date: Thu, 27 Oct 2016 21:04:43 +0000
From: Mueller, Berndt <bmueller@bnl.gov>
To: Morrison, David <morrison@bnl.gov>, Gunther M Roland <rolandg@MIT.EDU>
CC: O'Brien, Edward <eobrien@bnl.gov>, James Nagle <jamie.nagle@colorado.edu>

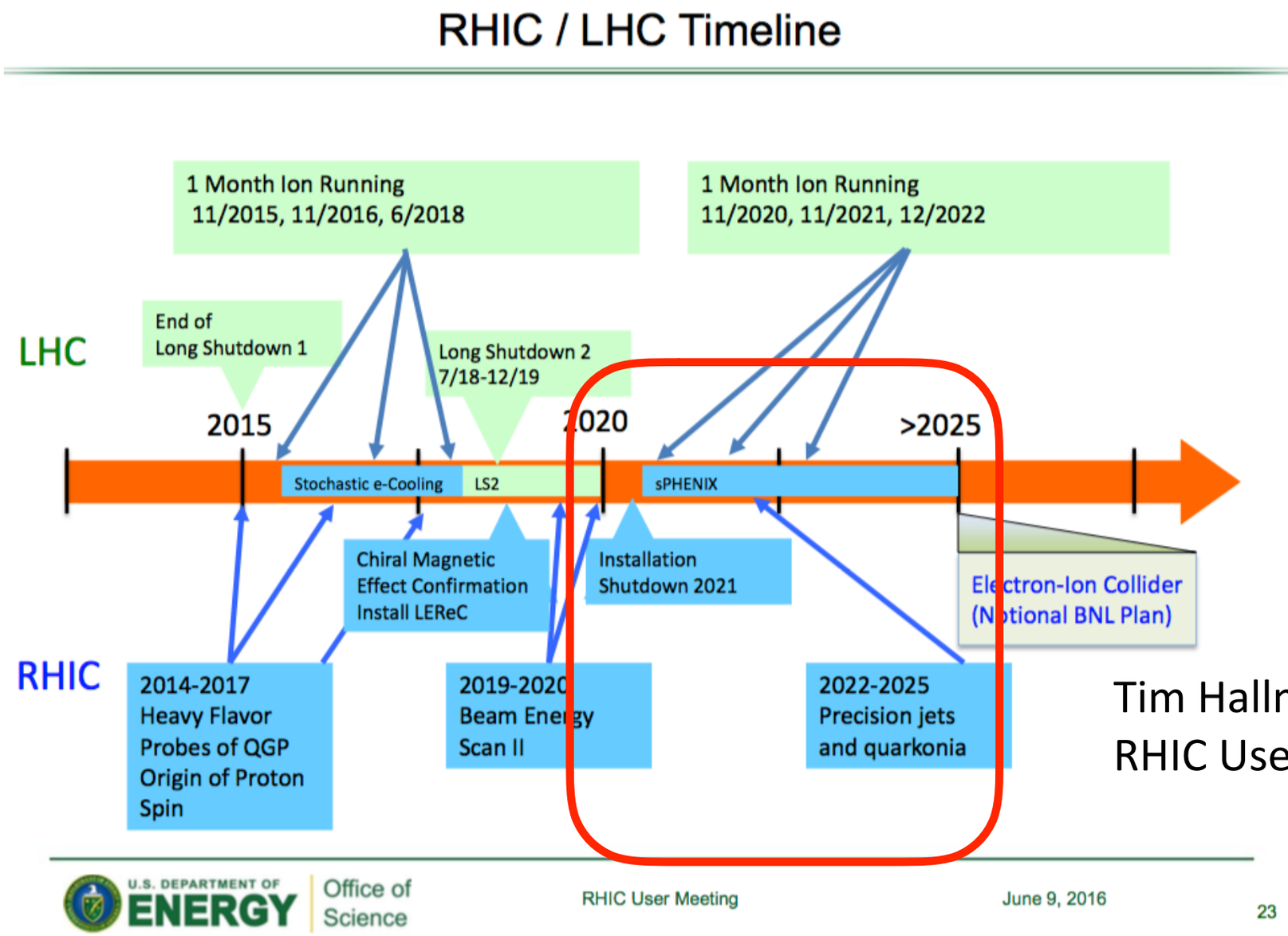
Dear Dave and Gunther (Cc: Jamie):

I just received word that CD-0 for sPHENIX was approved today. You can go and celebrate (for one evening).

Berndt

(more celebration is warranted)

# CD-0




Tim Hallman,
RHIC User's meeting

This reflects most recent DOE thinking – best to be agile and prepared for an sPHENIX lifetime of possibly half a decade.

# Growing the collaboration

# Collaboration survey

- Initial survey of Institutional Board to find out who, from each institution, should be a collaborator

- At Rutgers meeting: 59 institutions, 183 collaborators.

- Most of 2016 pre-CD-0, loss of some BNL staff, but adding new institutions, new collaborators

- Survey says: 61 institutions, 220 Collaborators

- ***Follow up with questionnaire to collaborators***

# New institutions

- Three new institutions expressed interest
  - Temple University
  - LBNL
  - UC Berkeley
- Presentations at IB meeting tomorrow

# Onto 2017

# Key issues for 2017

- Collaboration working together with Project toward CD-1
- MAPS MIE proposal
- Refreshing the LRP science case
- sPHENIX and EIC
- Growing the Collaboration
- Expanding collaboration infrastructure and practices

# Towards CD-1

| Project Phase | Critical Decision |
|---|---|
| **Initiation**<br>There is a need that cannot be met through other than material means. | CD-0, Approve Mission Need |
| **Definition**<br>The selected alternative and approach is the optimum solution. | CD-1, Approve Alternative Selection and Cost Range |
| **Execution**<br>Definitive cost, scope, and | CD-2, Approve Performance Baseline |
| schedule baselines have been developed. | |
| **Execution Project**<br>is ready for implementation. | CD-3, Approve Start of Construction |
| **Transition/Closeout**<br>Project is ready for turnover or transition to operations. | CD-4, Approve Start of Operations |

- Discussion today and on Saturday
- Opportunity and need for broad engagement by collaboration
- Simulations in support of CD-1

# MAPS MIE

- We have a possible path to “ideal” sPHENIX detector
- Need to prepare strong proposal ASAP
- Discussion tomorrow morning
- Workfest in Santa Fe, 1/5-1/7 2017

# Refreshing the science case

- sPHENIX future rests on LRP science case
- How to extract “microscopic nature” of QGP from proposed measurements is open question
- We need to lead this discussion
- Workshops planned next year (e.g., INT program May/June, possible BNL workshops)
- Need to engage with theorists (JETSCAPE)


- Refreshing the science case only helps if people know about it!
- Megan Connors has agreed to give the sPHENIX talk in the futures session – excellent!
- Many posters (next slide)
- Topical groups should come up with list of plots to produce by QM
- Not planning a pre-QM'17 meeting. Someone with an eye for design to develop some graphical tie-ins between sPHENIX posters?

# QM'17 posters - an excellent line-up

sPHENIX Tracking Performance Simulations, Veronica Canoa (SBU)
The intermediate tracking system of the sPHENIX detector at RHIC, Gaku Mitsuka (RBRC)
Jet spectra and jet structure measurements with sPHENIX, Rosi Reed (Lehigh)
sPHENIX TPC mechanical design, Klaus Dehmelt (SBU)
A Prototype of the sPHENIX Hadronic Calorimeter, Abhisek Sen (ISU)
Studying Proton Structure, the Partonic Structure of Nuclei, and Hadronization at sPHENIX, Chong Kim (UCR)
Identification of heavy-flavor jets in sPHENIX using MAPS, Cesar da Silva (LANL)
R&D Studies for the sPHENIX Time Projection Chamber, Prakhar Garg (SBU)
R&D for the sPHENIX MAPS inner tracker, Ming Liu (LANL)
A Common Readout System for the sPHENIX Electromagnetic and Hadronic Calorimeters, Eric Mannel (BNL)
The Readout and Data Acquisition Design of the sPHENIX Detector at RHIC, Martin Purschke (BNL)
Front End Readout for the sPHENIX Time projection chamber, Takao Sakaguchi (BNL)
Modification of Upsilon production in nuclear collisions measured with sPHENIX, Krista Smith (FSU)
Design of the sPHENIX tracker, Sourav Tarafdar (VU)
B-Jet Tagging Algorithms for sPHENIX at RHIC, Haiwang Yu (NMSU)
Test Beam Performance of the sPHENIX EMCal Prototype, Virginia Bailey (UIUC)
Construction and testing of the sPHENIX hadronic calorimeter prototype, Jamie Nagle (Colorado)
Design and test-beam performance of the sPHENIX calorimeter system, Jin Huang (BNL)

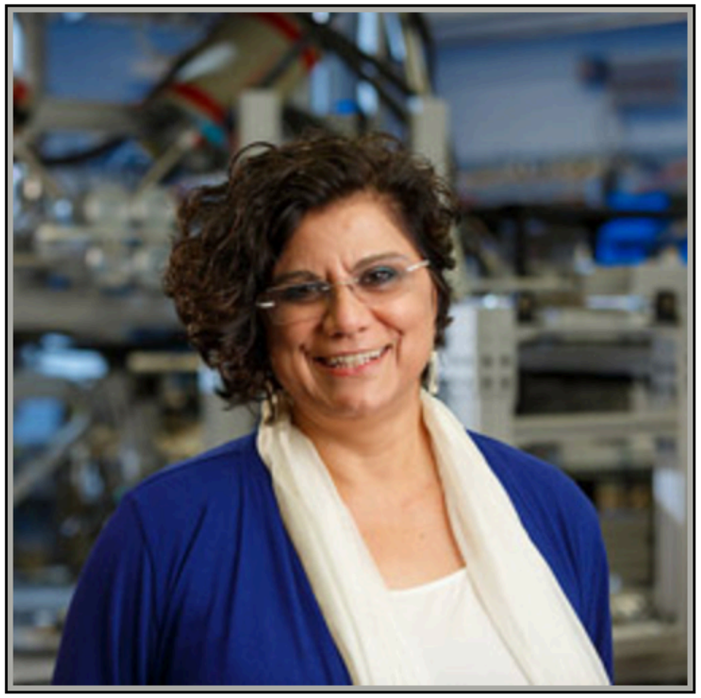
# sPHENIX and EIC

- Discussion today and on Saturday
- NAS committee formed
- Steadily increasing activity at BNL: existing EIC task force and EIC R&D efforts, meetings upon meetings, working groups, BNL upper management very focused on EIC, opening new positions (e.g., EIC Science Director, theory group)
- How can sPHENIX contribute? Do we need to lead effort?

# Aprahamian to co-chair U.S. Electron Ion Collider Facility Study

October 17, 2016 • Categories: News

Ani Aprahamian, Freimann Professor of Physics, has been named co-chair of a committee with the National Academy of Science on a U.S. Electron Ion Collider Facility. The committee will assess the scientific justification of a U.S. facility taking current international plans and existing domestic facility infrastructure into consideration. It will address the role that a facility could play in the future of nuclear physics, considering the field broadly, but placing emphasis on its potential scientific impact on quantum chromodynamics. Aprahamian will co-chair the committee with Prof. Gordon Baym of the University of Illinois. The study will begin immediately, the committee will meet in December, and will conclude in 2017.



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Ani Aprahamian, Co-Chair (University of Notre Dame)
Gordon Baym, Co-Chair (U. Illinois at Urbana-Champaign)
Christine Aidala (University of Michigan)
Richard Milner (MIT)
Ernst Sichtermann (LBNL)
Zein-Eddine Meziani (Temple University)
Thomas Schaefer (NC State University)
Michael Turner (University of Chicago)
Wick Haxton (University of California-Berkeley)
Kawtar Hafidi (Argonne)
Peter Braun-Munzinger (GSI)
Larry McLerran (University of Washington)
Haiyan Gao (Duke)
John Jowett (CERN)

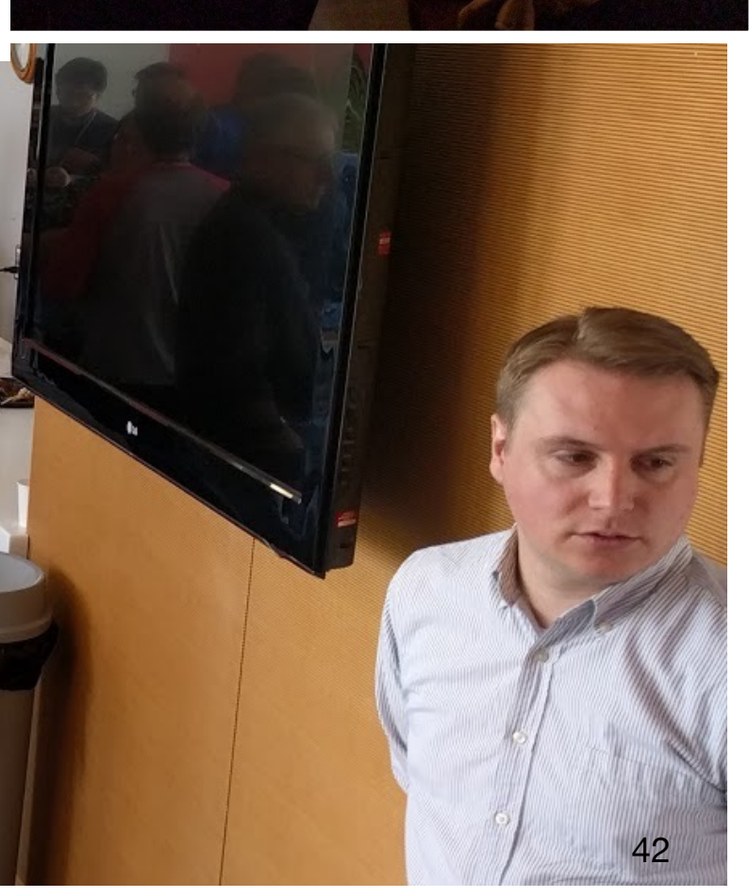
# Growing the collaboration

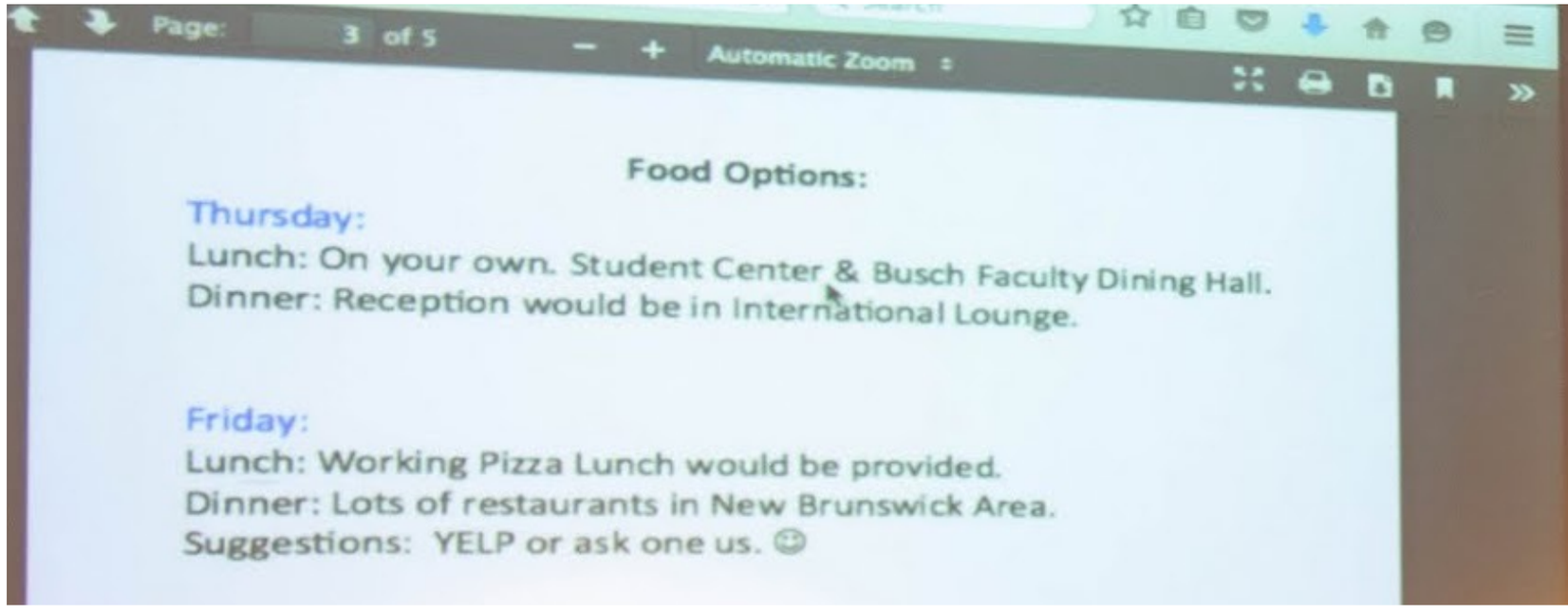
- Expect continued discussion with various US institutions
  - STAR, LHC commitments vs new-found clarity through CD-0
- Need to increase international footprint
  - Europe
  - Asia
- Input from collaboration - time to talk to your friends

# Collaboration infrastructure and best practices

- Looking for a way to establish an sPHENIX office
  - speaker's bureau, web presence, outreach, document archival
  - complicated by recent BNL RIFs and retirements
- More formal process for technical and physics documentation
  - internal notes supporting plots and figures
  - lightweight review process – perhaps just one non-author editor?
- Input from collaboration - what works? what doesn't? what's missing?

# Food and discussion






# Rutgers Univ.
# December 2015

# A Collaboration thinks best on a full stomach – a fine tradition continues here at GSU

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